Remarks

Claims 1, 17, 20, 22, 33, 34, 35, 40, 47 and 48 are amended to recite that the spacing of the sub-carriers of the sub-carrier multiplexed signal is substantially equal to an integer multiple of 1/(Symbol period). This is based on the features of dependent claim 2 and others, which are correspondingly cancelled.

Claims 49, 51, 53, and 55 are amended to recite that the optical data signal is an orthogonal frequency division multiplexed optical signal (based on claims 50, 52, 54 and 56, respectively).

Both sets of amendments are equivalent and serve to clarify that the sub-carrier multiplexing in question is Orthogonal Frequency Division Multiplexing (OFDM). The equivalence of specifying this feature in terms of the relationship between the sub-carrier spacing and the symbol period is outlined at p.19, lines 4-10 of the application as filed.

Claim rejections under 35 USC § 103

Claims 1, 3-9, 11, 12, 16, 20, 22, 23, 27, 28, 32 and 34 stand rejected under 35 USC § 103(a) as being unpatentable over Smart et al. (US 2002/0041637) in view of Shpantzer et al. (US 2002/0186435) and Agazzi (US 6,879,640). This rejection is traversed in light of the following comments.

Smart et al. discloses an improvement to conventional Orthogonal Frequency Division Multiplexed (OFDM) communications. Improved performance is achieved by using a "sliding window" transform. At paragraph [0074], Smart notes that OFDM transmissions can be delivered over a variety of media, including – among many others – an optical fiber. The implication is that the invention of Smart is not limited as to physical medium. However, the implication is also that the list of media given is merely exemplary, and none of the listed examples is of particularly greater interest than any other. Smart fails to teach that OFDM is particularly advantageous in the context of optical communications.

This teaching is absent because Smart did not recognize the special advantages of OFDM in this context. This is unsurprising, since Smart was primarily concerned with RF communications. This can be seen from paragraphs [0025-0027], for example, in which the problems of multi-path delay spreads are considered at some length. Multi-path effects are of course irrelevant in the context of communication over optical

fiber, whereas they are highly relevant in free-space RF transmission (especially in mobile communications). Further confirmation is provided by paragraph [0005], which refers to channels "such as, for example, RF channels, power line channels and the like". Furthermore, no specific problems are mentioned in relation to optical communications anywhere in Smart – despite these problems being very different to those encountered in the RF domain.

All of this evidence suggests that the only reason that Smart mentions the medium of optical fiber is merely to clarify that, although wired and wireless RF channels are of primary interest, there may be other types of channel where OFDM could also be used – albeit with less benefit.

A person of ordinary skill in the art of optical communications therefore has no reason to consult Smart et al. Moreover, even if Smart was to be considered by such a person, Smart does not suggest that OFDM might be beneficially applied in the field of optical communications, let alone that data rates over 10Gbps could be achievable.

Agazzi discloses multi-carrier modulation for fiber-optic systems, wherein a series of electrical carriers is modulated separately and then combined to form a wide-band signal (see Agazzi, abstract). The system of Agazzi is therefore of the type already acknowledged at p.2, lines 15-31 of the present application as filed.

Compared with such a system, the present invention has the advantages described at p.3, lines 27-32 of the application as filed: namely, the spectral efficiency of the transmission system is increased beyond that possible with a conventional system, because the sub-carriers can overlap in frequency space without interfering with one another. Thus, the present inventors have achieved a significant further advance in spectral efficiency, compared with Agazzi. This paves the way for further substantial increases in throughput, since each of the modulated carriers of Agazzi can in fact be replaced with an OFDM scheme (compare claim 17, presently withdrawn, for example).

To make this leap was not obvious at the priority date. As shown previously above, Smart would not have been consulted by a person of ordinary skill in the art of optical communications. Agazzi gives the skilled person no reason to consult Smart, nor does Smart provide any motivation to consult Agazzi. Recall that these two references lie in different technical fields and are concerned with different problems –

Smart with improving OFDM for RF communications and Agazzi with increasing the capacity of optical fiber.

Indeed, to this extent, the teachings of the two references are actually mutually incompatible: Agazzi teaches that, to increase the bandwidth of an optical system to 10Gbps, multiple, well-separated carriers should be used. In particular, Agazzi gives an example in which each mixer has a frequency which is separated from successive mixer frequencies by 200MHz (see Agazzi, col.9, lines 16-21). Meanwhile, Smart advocates OFDM (wherein the sub-carriers overlap) for solving the problems associated with wired and wireless RF channels, such as multipath, amplitude fading, phase shifts and noise (see Smart, paragraph [0005]). There is no reason that the skilled person in the field of optical communications would apply the latter approach in his/her own field, since the problems which Smart purports to solve do not apply to optical fibers. Conversely, there is nothing to suggest that the problems of optical fiber can be solved by applying the OFDM system of Smart.

Only with hindsight can it appear obvious to selectively combine elements of the two references: using the OFDM system of Smart to replace the multi-carrier modulation of Agazzi. Without the benefit of hindsight there is no reason even to consider the two references together. The hindsight analysis overlooks the synergy in the specific combination of elements and advantages flowing from it.

The present invention is of such significant advantage to the field of optical communications that, had it been obvious to a person of ordinary skill at the priority date, it would undoubtedly already have been done. The fact that the invention had not been made before confirms the Applicant's belief that it was not, in fact, at all obvious.

The patent to Agazzi has been issued despite the undoubted existence in the prior art of other communications systems, in different fields, using similar multi-carrier modulation schemes. This is because it was non-obvious to apply these multi-carrier ideas in a new way, in a different field (optical communications). The present case is no different – and it makes a significant additional technical contribution beyond that of Agazzi.

It is therefore respectfully submitted that each of the amended independent claims is non-obvious over the cited references, individually or in any combination.

Further and favorable reconsideration is respectfully requested.

A Petition for Extension of Time is also submitted herewith.

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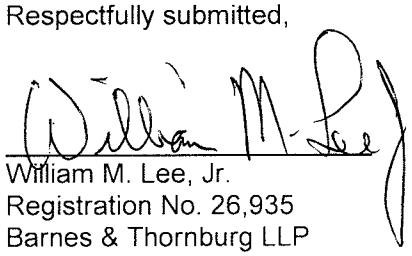
Respectfully submitted,



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